STEM Investment and Economic Growth

Data Preparation and Variable Setup

This study aimed to explore whether investment in STEM fields has a measurable impact on economic growth. The dataset is focusing on four economic indicators — GDP, interest rate, stock index, and inflation rate. To construct a clear comparison, the average STEM investment from 2020 to 2023 was calculated for each country. Based on this average, nations were divided into two groups: High STEM Investment and Low STEM Investment. Each economic indicator was treated as a dependent variable, while the investment level served as the independent variable.

To ensure consistency across sources, monthly data were aggregated into yearly averages, and country names were standardized across different datasets. In addition, all financial values were converted into U.S. dollars using the exchange rates from the corresponding years, allowing a direct comparison of investment and economic indicators among nations.

Before testing, missing values were removed and variables were standardized to maintain consistent units. Extreme outliers were excluded using the IQR method, ensuring a balanced distribution. This refinement allowed a fair comparison between both groups and reduced bias from countries with unusually large or small values.

T-test

A series of independent T-tests examined whether the means of the two investment groups differed significantly for each economic variable.

- GDP vs STEM Investment: $t = 1.9984$, $p = 0.0654$ → Fail to reject H_0
- Interest Rate vs STEM Investment: $t = -0.9614$, $p = 0.3412$ → Fail to reject H_0
- Stock Index vs STEM Investment: $t = -1.0941$, $p = 0.2794$ → Fail to reject H_0
- Inflation Rate vs STEM Investment: $t = 0.4190$, $p = 0.6767$ → Fail to reject H_0

Overall, all p-values exceeded 0.05, suggesting no statistically significant difference in any single indicator between the high and low investment groups.
However, GDP stood out with a p-value of 0.065, slightly above the threshold, implying a potential near-significant relationship worth further investigation.

F-test (MANOVA)

While the T-test analyzes each variable independently, the MANOVA considers the combined variance across all economic indicators. Here, STEM investment level (high vs low) was the independent variable, and GDP, interest rate, stock index, and inflation were the dependent

variables.

- Wilks' Lambda = 0.2192, p = 0.0000

The result shows that the overall difference in economic patterns between the two groups is statistically significant.
This means that while no single variable alone passed the T-test threshold, the collective behavior of the indicators clearly distinguishes the two groups. In other words, STEM investment influences the broader economic structure rather than isolated metrics.

Linear Regression: STEM Investment as a Predictor of GDP

To examine the direct relationship between STEM investment and economic growth, a simple linear regression model was built using GDP as the main dependent variable.

$$GDP_{mean} = -33{,}202.35 + 156.03 \times STEM_{Investment}$$

$R^2 = 0.9609$

The model revealed a strong positive linear relationship between STEM investment and GDP. As nations allocate more funds to STEM fields, their average GDP tends to rise sharply, demonstrating that research and innovation investment directly supports national economic performance.

By contrast, the other models (Interest Rate, Stock Index, Inflation) had very low explanatory power:

- Interest Rate: $R^2 = 0.0013$
- Stock Index: $R^2 = 0.0056$
- Inflation Rate: $R^2 = 0.0047$

These low R^2 values suggest that while STEM investment might interact weakly with these indicators, it does not strongly determine them. Economic growth, in this case, is best captured through GDP as the primary dependent variable.

Interpretation

Synthesizing these results reveals an interesting pattern. The T-test, limited to single-variable comparisons, largely supported the null hypothesis. Yet, the F-test rejected it by identifying statistically significant overall differences when viewing the economy as an interconnected system. Among all indicators, GDP emerged as the most responsive to STEM investment — slightly near-significant in the T-test and highly correlated in the regression model. This indicates that economic expansion through innovation funding cannot be fully understood by examining one metric at a time. Instead, it operates through a combined, systemic mechanism where STEM spending strengthens productivity, technology capacity, and long-term national

output. Therefore, relying solely on univariate tests like the T-test underestimates the complexity of economic growth. The F-test and regression analysis together provide a more complete picture, confirming that STEM investment plays a substantial role in driving sustainable economic development.

conclusion

In conclusion, this study evaluated whether to accept or reject the null hypothesis stating that STEM investment does not significantly affect economic growth. While the T-test results generally supported the null hypothesis, showing no significant differences among individual variables, the F-test and regression analysis provided stronger evidence in favor of the alternative hypothesis. These multivariate approaches revealed that STEM investment is systematically linked to the overall economic structure, especially through its positive association with national productivity and innovation capacity. Because economic growth is shaped by multiple interdependent factors, it is more reasonable to interpret the results within a broader analytical framework rather than through isolated variables. Therefore, based on the comprehensive patterns observed across the analyses, the alternative hypothesis—that STEM investment contributes to economic growth—is supported.